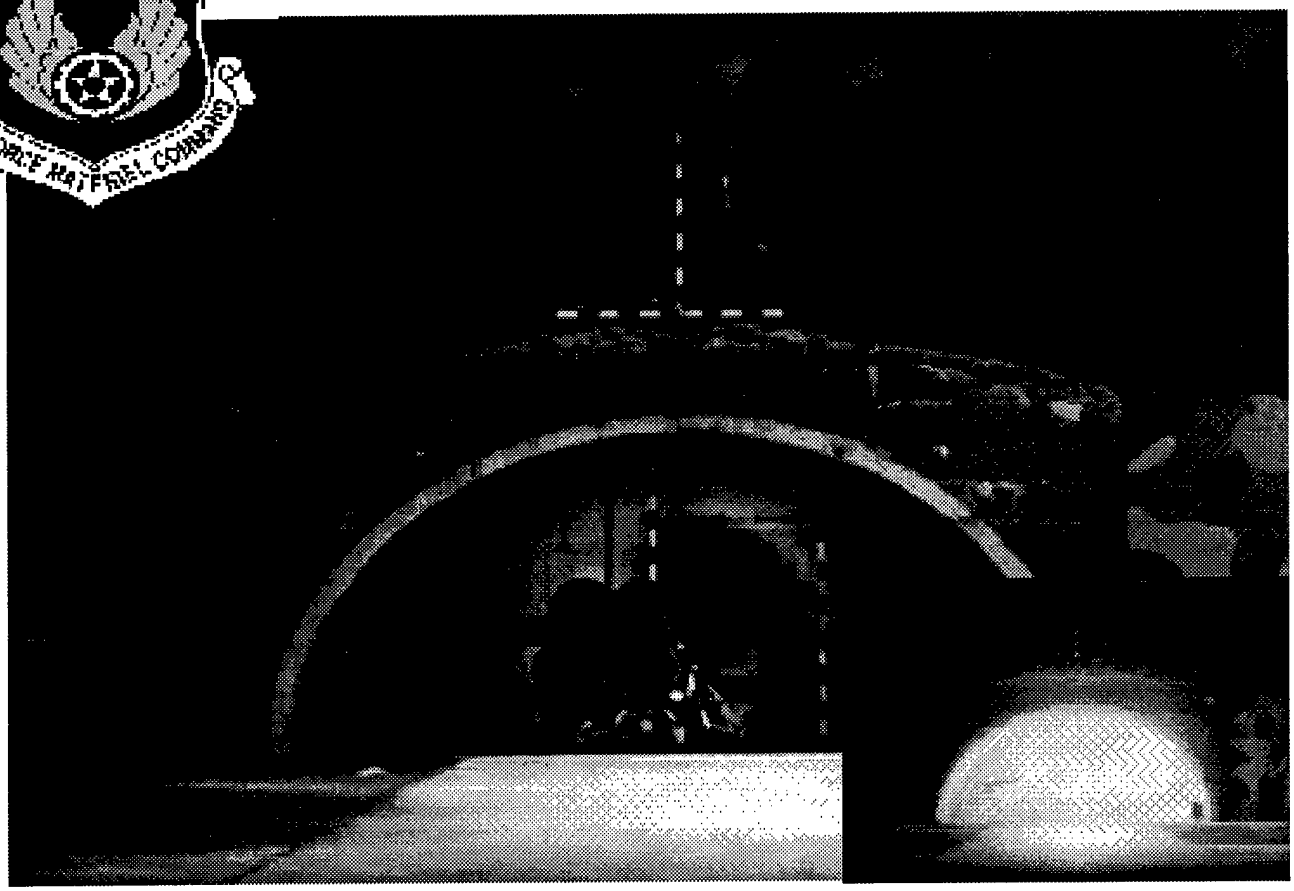
FY 98
CONVENTIONAL ARMAMENT TECHNOLOGY AREA PLAN



AIR FORCE RESEARCH LABORATORY
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About the cover: As part of Team Eglin, The Armament Directorate has successfully developed a 250-lb class munition to greatly increase loadout capabilities for fighter bomber aircraft. The cover shows the Miniaturized Munition Technology (MMT) munition penetrating an aircraft shelter and destroying (see insert) the A-7 aircraft and other support equipment inside

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13. ABSTRACT *(Maximum 200 words)*

CONVENTIONAL ARMAMENT S&T IS CARRIED OUT BY THE ARMAMENT DIRECTORATE AT EGLIN AIR FORCE BASE, FL. THE PRIMARY ROLE OF THE ARMAMENT DIRECTORATE IS TO PERFORM RESEARCH AND DEVELOPMENT TO TRANSITION CONVENTIONAL ARMAMENT TECHNOLOGIES THAT MEET OUR CUSTOMER'S NEEDS. IN LINE WITH THE THE AIR FORCE'S NEW STRATEGIC VISION "GLOBAL ENGAGEMENT: A VISION FOR THE 21ST CENTURY AIR FORCE," OUR VISION IS TO PURSUE THE DEVELOPMENT OF THE NEXT GENERATION PRECISION GUIDED CONVENTIONAL MUNITIONS. THEY MUST BE WEAPONS THAT WILL ENABLE AMERICA'S FIGHTING FORCE TO TARGET, SURGICALLY STRIKE AND DISABLE A WIDE VARIETY OF TARGETS. THEY MUST BE WEAPONS THAT MINIMIZE COLLATERAL DAMAGE AND REDUCE THE RISK TO CIVILIAN POPULATIONS AS WELL AS THE ENVIRONMENT.

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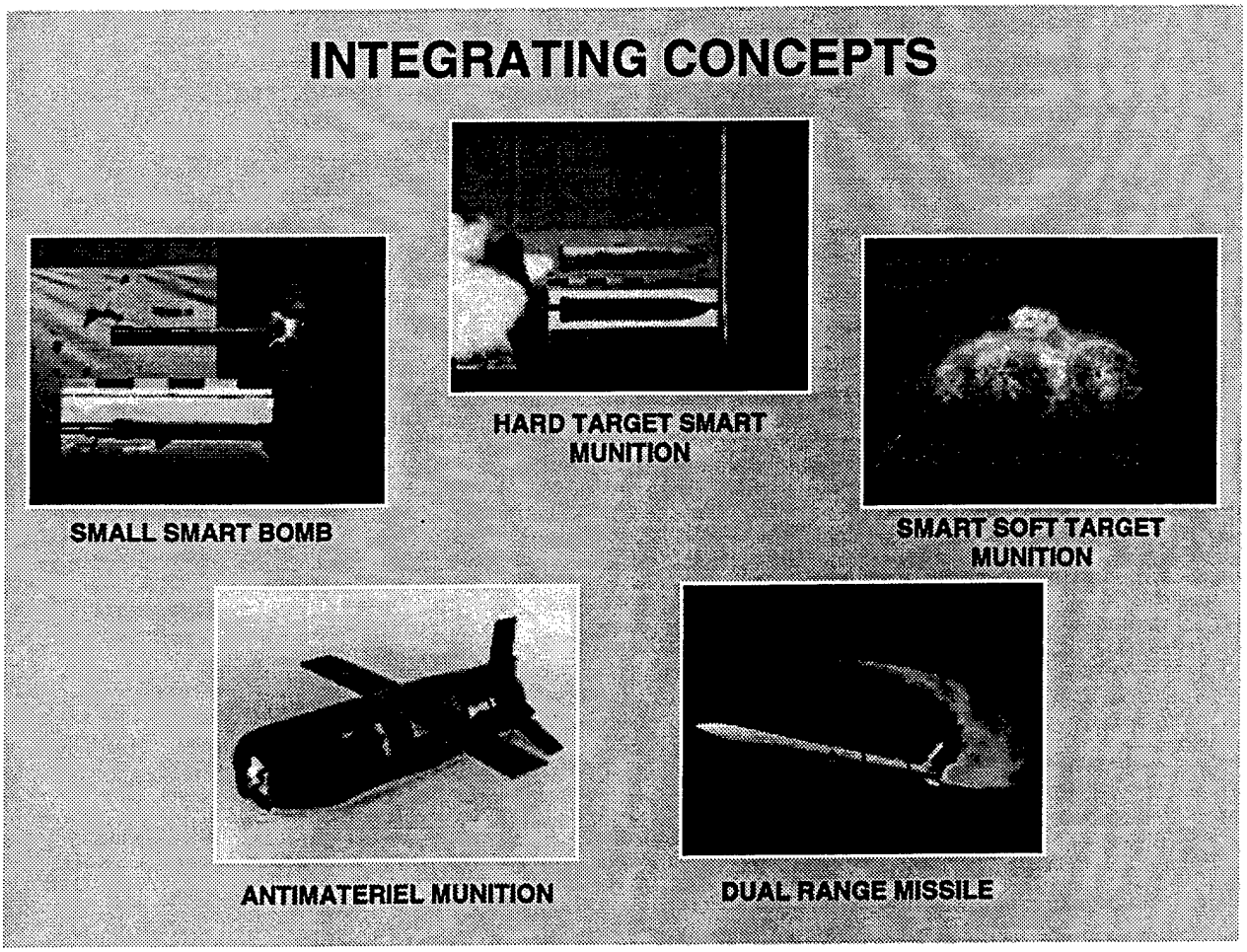
CONVENTIONAL ARMAMENT



VISIONS AND OPPORTUNITIES

With the Air Force's Fiftieth Anniversary at hand, the Armament Directorate, Eglin AFB, Fla., thought it fitting to pause, take a look back over the past five decades, and reflect upon half a century of conventional weapons accomplishments in the U.S. Air Force. After doing so, we believe we can now start the long look ahead into our future and begin to adapt our vision to meet the Air Force's conventional weapon needs as defined by the Air Force's new strategic vision "Global Engagement: A vision for the 21st Century Air Force."

Our vision is to pursue the development of next generation precision guided conventional munitions. It is of paramount importance to the warfighter that the weapons developed be versatile, autonomous, and provide greater lethality in all weather conditions. Above all, they must be affordable. They must be weapons that will enable America's fighting force to target, surgically strike, and disable a wide variety of military targets. They must be weapons that minimize collateral damage, and reduce the risk to civilian populations as well as the environment. These next generation weapons will allow the Air Force to accomplish the core competencies -- those of air and space superiority, global attack, and precision engagement -- while enhancing the core competencies of rapid

global mobility, information superiority, and agile combat support.

The Armament Directorate and its associated technology thrust leaders are using the idea of Integrating Concepts as the organizing principle to focus its technical planning activities in order to meet our vision. The five Integrating Concepts currently used are depicted in the above graphic: one focuses on mobile surface targets (the Antimateriel Munition); another on airborne targets (the Dual Range Missile); and the remaining three focus on fixed surface targets (Small Smart Bomb, Hard Target Smart Munition, Smart Soft Target Munition). To promote efficient integrated planning, these concepts are managed by an interdisciplinary Integrated Product Team (IPT). Each concept facilitates a system-based approach rather than a series of independent component or technology based approaches. The Integrating Concept IPT (ICIPT) establishes long-term visions, operational performance goals, and technology subgoals within the context of their particular munition system and its mission application. The various technology programs described in this Technology Area Plan were selected because their successful execution will provide technology options for the long-term visions of these Integrating Concepts.

Our senior planners promote revolutionary thinking by ensuring the visions and performance attributes of the five Integrating Concepts utilize the ideas of the Air Force Scientific Advisory Board's New World Vistas and other far-term thinking efforts such as Air Force 2025 as the guiding force in selecting which programs to fund.

It is the goal of the individual thrusts to use the visions of the ICIPTs, the revolutionary ideas of the New World Vistas, and the far-thinking ideas of the Air Force 2025 and make them reality. They will furnish the necessary technical knowledge and facilities to turn seekers, sensors, fuzes, and ordnance research into hardware that meets the future air-to-surface and air-to-air conventional weapon needs of the Air Force... hardware the warfighter can depend upon and use as an effective tool in order to survive and fight again.

The development of highly effective and affordable conventional armament technologies for the Air Force is our vision. By working together with the system program offices and Air Force Test ranges located at Eglin AFB, the munition technology development, system acquisition, and testing that is critical to the Air Force will be developed and maintained to meet our current and future munition needs.

This plan has been reviewed by all Air Force laboratory commanders/directors and reflects integrated Air Force technology planning. I request Air Force Acquisition Executive approval of the plan.

RICHARD W. DAVIS
Colonel, USAF
Commander Wright Laboratory

RICHARD R. PAUL
Major General, USAF
Technology Executive Officer

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CONVENTIONAL ARMAMENT TECHNOLOGY AREA PLAN

INTRODUCTION

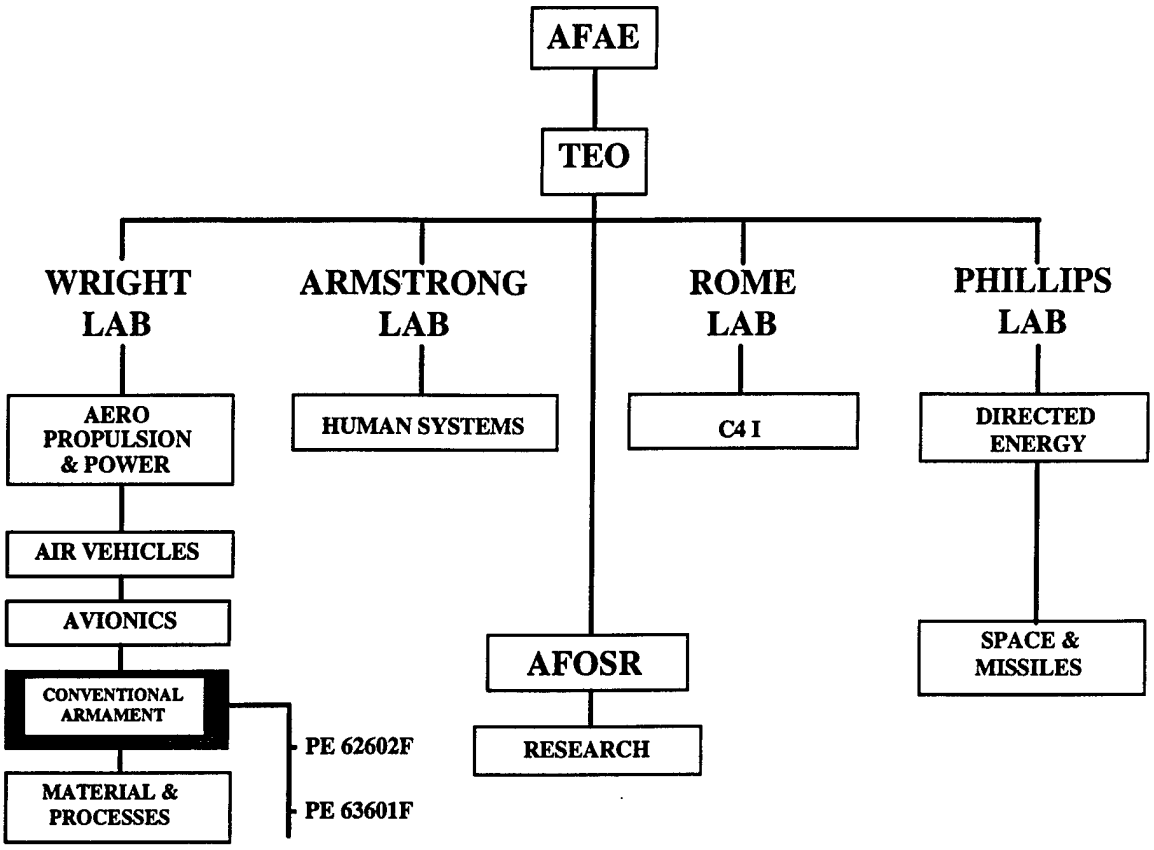


FIGURE 1. AIR FORCE SCIENCE AND TECHNOLOGY PROGRAM STRUCTURE

Background

The Air Force Materiel Command organization for Science and Technology (S&T) is depicted in Figure 1. Within this structure, Conventional Armament S&T is carried out by the Armament Directorate at Eglin Air Force Base (AFB), FL. We have two Program Elements (PEs) as shown. The primary role of the Armament Directorate is to perform research and development to transition conventional armament technologies that meet our customers' needs. Figure 2 illustrates the FY98 Conventional Armament investment compared to the overall Air Force S&T budget. Conventional Armament is approximately 5.6 percent of the S&T budget.

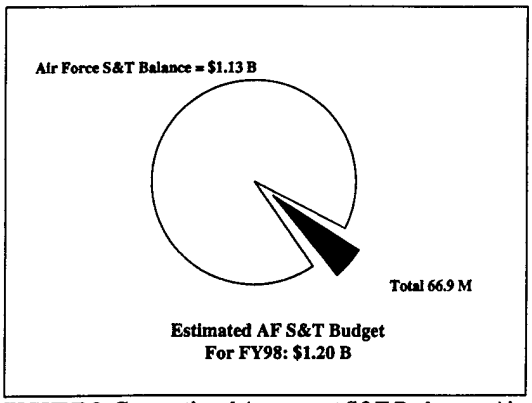


FIGURE 2. Conventional Armament S&T Budget vs. Air Force S&T Budget

The fundamental technology areas or major thrusts for Conventional Armament are shown in Table 1.

Table 1. Major Technology Thrusts

1. **Advanced Guidance**
2. **Ordnance**

These thrusts encompass a broad spectrum of technologies that form the basis for enabling new/innovative concepts for air-launched weapons. **To relate User's Needs to conventional armament technology, the thrust descriptions begin with an abbreviated listing of combat user needs extracted from Mission Area Plans and other requirements documents. These needs are expanded and highlighted in boldfaced type in the "Goals" section along with the technologies being pursued to solve the needs.** The thrust descriptions conclude with accomplishments from last year, program changes, and milestones for the future. Figure 3 is the apportionment of AF S&T conventional armament funding for the two major thrusts.

The Advanced Guidance Thrust develops the terminal seekers and guidance and navigation technology that provide the precision in a precision guided weapon. Accomplishments during the past year include advancements in conformal antenna design and application, the initiation of a flight demonstration program for Synthetic Aperture Radar (SAR) seekers, and significant cost reduction in inertial measurement units.

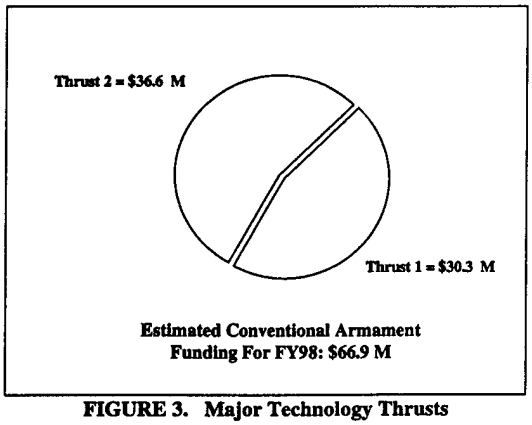


FIGURE 3. Major Technology Thrusts

The Ordnance Thrust is responsible for the development of explosives, warheads, fuzes, weapon airframe controls, and carriage and release equipment, and receives the largest share of the Conventional Armament S&T budget. Major accomplishments during the past year include the completion of the development of a hard target smart fuze, the development of a dense explosive for penetrating weapons, and the demonstration of a 1000-lb penetrator warhead for the Joint Advanced Strike Aircraft and F-22. Technology assessments are conducted in all of these thrusts to provide program managers insight into critical design issues and to ensure the technologies are focused to satisfy the user's requirements. All funding figures reflect the FY98 President's Budget Request, and the programs described in this plan are subject to change based upon possible Congressional action.

Relationship to Other Technology Programs

Our thrusts are coordinated with the other 10 technology areas of Air Force S&T. Special attention is placed on maintaining a

close relationship with areas that are vital to armament development such as materials, avionics, air vehicles, and aeropropulsion and power. This awareness ensures our thrusts can benefit from work performed in these areas.

To keep abreast of technologies, we participate in joint programs, data exchanges, and technical interfacing with other Air Force organizations, services, government agencies, National Laboratories, industry, and foreign countries. We maintain an interface and support programs carried out by these organizations so that we can leverage their technical expertise and fill our technical gaps. We also maintain a working relationship with aircraft System Program Offices (SPOs) to provide them with technologies for new weapons, missile launchers, and bomb release units for advanced aircraft. Together we work to support each other so that the SPO and our technology needs are met.

We leverage our technologies with the commercial sector where possible. Where there is limited commercial interest such as in the explosives, warheads, and fuzes area, we conduct more in-house research and expend more resources than private industry to advance this technology.

The Armament Directorate has implemented a broad based technology transfer program. Outreach to industry, patenting, marketing, and cooperative efforts are all a part of the directorate program. We are actively involved with industry through Cooperative Research and Development Agreements to promote the commercialization of Subminiature Telemetry, High Speed Imaging, and layered ceramic materials for gun barrel applications. The Armament Directorate is an active member of the Gulf Coast Alliance for Technology Transfer for the purpose of assessing and commercializing our technologies and is also an active member of the Federal Laboratory Consortium for technology transfer.

The Directorate has several International Exchange Agreements with foreign countries around the world. The primary emphasis is in the ordnance area. A number of joint tests were completed last year, and more are scheduled for the coming year.

Changes from Last Year

As a result of the drive to develop conventional munitions that are smaller, it is necessary to increase the focus on the next generation seeker/sensor technology that will provide the accuracy necessary for the smaller munitions to perform as well as current munitions. Therefore, the funding for Thrust 1: Advanced Guidance Thrust will reflect a more equal distribution of funding between the two thrusts.

USER NEEDS

The focus of this thrust is on the development of terminal seeker, sensor, processing, and guidance and navigation technologies for affordable autonomous weapons capable of all weather precision guidance. User needs have been extracted from the Air Combat Command (ACC) Mission Area Plans for Counter Air, Strategic Attack/Interdiction, Close Air Support/ Interdiction, Theater Missile Defense, and Electronic Combat.

AIR-TO-SURFACE

Hard Target Smart Munition
Smart Soft Target Munition
Small Smart Bomb

- Multiple Kills per Pass
- Minimal collateral damage
- Autonomous target acquisition and precision aimpoint tracking in weather with affordable, countermeasure resistant seekers
- Real-time targeting and damage assessment
- Steep dive angle target acquisition and aimpoint tracking for penetrating munitions
- Reduced mission planning requirements
- Intelligent Antijam Global Position System /Inertial Navigation System (GPS/INS) guidance
- Low cost, small, and accurate Inertial Measurement Units (IMUs)

Antimateriel Munitions

- Autonomous target classification and tracking in weather with affordable, countermeasure resistant seekers
- Real-time targeting
- Identification of friend or foe
- Guidance Integrated Fuzing

AIR-TO-AIR

Dual Range Missile

- Improve Advanced Medium Range Air-to-Air Missile (AMRAAM) /AIM-9 kinematic performance
- Increased electronic countermeasure (ECM) resistance and broader target set
- Identification of friend or foe
- Capability against cruise missiles
- Improved guidance laws/autopilots for enhanced lethality and faster intercept
- Low cost, small, and accurate IMUs
- High off-boresight lock-on and track capability with affordable seekers
- Guidance Integrated Fuzing

See Figure 4 for major Thrust efforts.

GOALS

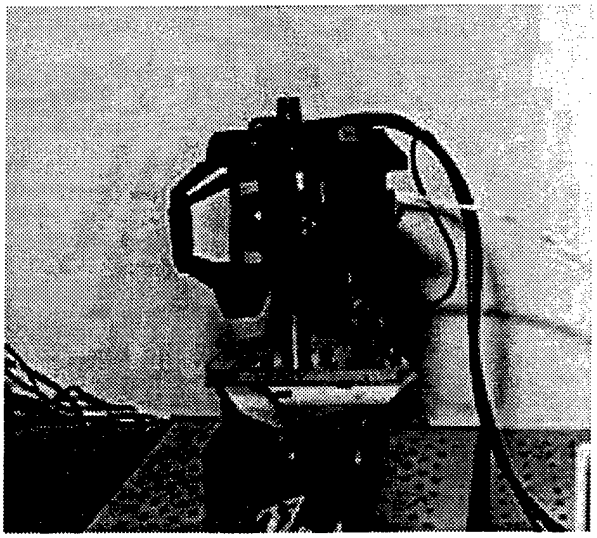


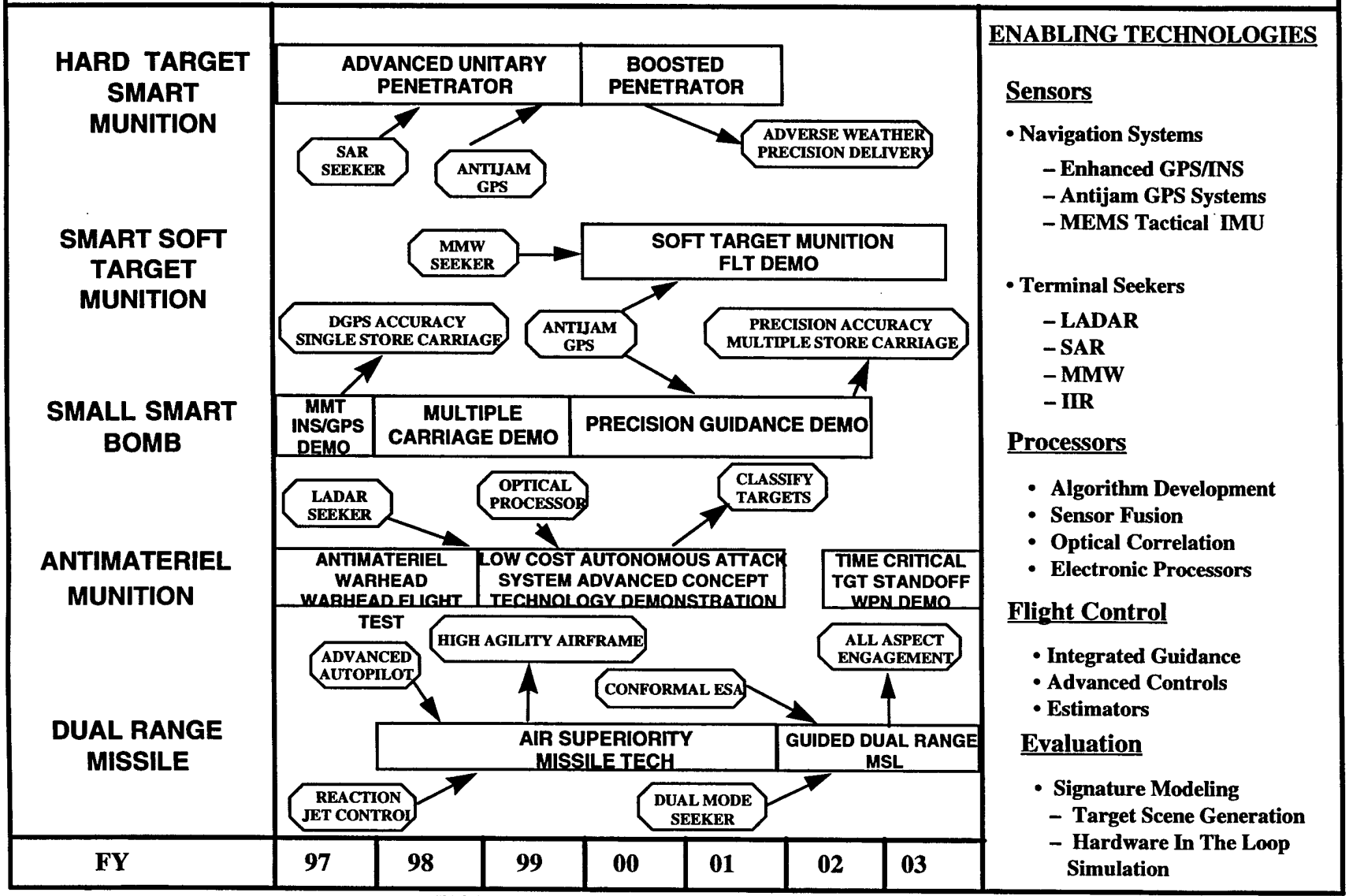
FIGURE 5. LADAR

AIR-TO-SURFACE

Hard Target Smart Munition
Smart Soft Target Munition
Small Smart Bomb

The Hard Target Smart Munition (HTSM), the Smart Soft Target Munition (SSTM) and Small Smart Bomb (SSB) subthrusts are developing low cost advanced penetrating warheads and accurate guidance technologies for use against soft, fixed and hardened targets. The Advanced Guidance thrust focuses on the development of affordable, all-weather precision

GUIDANCE THRUST



ENABLING TECHNOLOGIES

Sensors

- Navigation Systems
  - Enhanced GPS/INS
  - Antijam GPS Systems
  - MEMS Tactical IMU
- Terminal Seekers
  - LADAR
  - SAR
  - MMW
  - IIR

Processors

- Algorithm Development
- Sensor Fusion
- Optical Correlation
- Electronic Processors

Flight Control

- Integrated Guidance
- Advanced Controls
- Estimators

Evaluation

- Signature Modeling
  - Target Scene Generation
  - Hardware In The Loop Simulation

FIGURE 4: ADVANCED GUIDANCE THRUST

seekers and sensors that provide target interrogation optimal aim point selection.

Both current and future fighters such as the F-22, and the Joint Strike Fighter (JSF) demand the weapon size and weight be decreased in order to increase weapon loadout while reducing platform cost and collateral damage. This reduction in munition size requires a combination of improved precision guidance, enhanced energy/kill mechanism technologies and enhanced fuze control.

- Demonstrate utilizing a GPS/INS guidance system on a first generation 250-lb munition capable of penetrating 6 feet of concrete and defeating 85 percent of the BLU-109 target set.

- Demonstrate in a follow-on program an integrated terminal seeker version of the miniature munition and technologies for enhancing warhead effectiveness against soft targets.

The air-to-surface laser guided weapons currently in the inventory require designation of the target by laser. A successful mission requires; the designator remain in the target area until weapon impact, the weather be good enough to allow acquisition of the target by the designator, and for the weapon to track the reflected energy. Desert Storm highlighted the need for precision guidance (minimum collateral damage) and this weather limitation. **These considerations have led to the requirement for autonomous, all-weather, countermeasure resistant, precision seekers for our weapons.**

- A near-term goal is to demonstrate a SAR seeker capable of guiding a conventional direct attack weapon to a fixed high value target within 3 meters in adverse weather and at a cost of less than $40K per unit in quantities of 5000.

- Develop and demonstrate solid-state laser radar (LADAR) seeker (Figure 5) and algorithms for precision guided munitions. The Demonstration of Advanced Solid State Ladar (DASSL) program will develop the LADAR seeker for use in the Miniaturized Munition Technology Demonstration (MMTD) Program.

- Develop and demonstrate jam-resistant, all-weather, day/night, forward-looking, wide field-of-regard, high resolution, millimeter wave, radiometric imaging sensor.

- Investigate emerging technologies in millimeter wave (MMW), LADAR, and passive infrared (IR) that add new signature sensing capabilities to current seekers by the exploitation of polarization diversity and various spectral sensitivities for the different frequency regimes.

- Develop in-house research test-beds such as the MMW Reflectivity Measurement System (MRMS), the Research and Seeker Emulation Radar (RASER), the Laser Radar Brassboard, and the Advanced Guidance Research Facility (AGRF) to further the goal of identifying affordable concepts and components and reducing the life cycle cost of seekers.

Real-time targeting offers mission flexibility in a rapidly changing battlefield. It allows the aircraft real-time updates of the location of mobile targets as well as the opportunity to change to an alternate high value target. Several techniques are being investigated to address this capability which include using data from either on-board or off-board sensors on the aircraft. In addition, the seeker may use inputs from multiple types of sensors operating in different parts of the electromagnetic spectrum.

- A midterm goal is to demonstrate real-time targeting for a SAR seeker using either on-board or off-board sensor information.

Acquiring and attacking fixed hard targets presents some unique problems. **In order to employ penetrating weapons optimally, the seeker must be able to acquire the target at a steep dive angle and remain locked on until target impact. Also, determining the damage following an attack is difficult, especially for buried or covered targets such as command control bunkers and aircraft shelters.**

- Develop seekers capable of all-weather, autonomous acquisition, and precision tracking of fixed hard targets at steep dive angles.

- Develop and demonstrate methods to obtain real time battle damage assessment for fixed hard targets.

Traditionally, mission planning for a strike against fixed high value targets with stand-off weapons can take up to several days. This timeline begins from receipt of targeting material through reference template generation to validation. Because of this, the number of sorties flown and targets attacked in a given time period is limited.

- Develop algorithms and tools for weapons which will assist in reducing mission planning times from days to minutes to increase sortie generation.

Whether used alone or with a terminal seeker for precision accuracy, GPS/INS weapon guidance is the way of the future. GPS/INS guidance provides a low cost, highly accurate, day/night, all weather guidance system for tactical weapons. As a result, GPS/INS guided munitions are currently being developed for direct attack and stand-off applications. Although impervious to weather, the weapon's GPS receiver could be rendered useless due to high intensity jamming resulting from the proximity to colocated jammers in the vicinity of the target

- Develop a low cost, small, smart GPS/INS weapon guidance system for weapon options which will be resistant to jamming by known and postulated threats.

- Develop antijam GPS technology for tactical weapons in direct support to the Joint Direct Attack Munition (JDAM) and future tactical weapons.

Low cost, highly reliable, miniature IMUs are essential for air-to-air and air-to-surface weapon options, and for GPS/INS guidance systems. The next generation of IMUs will be based on innovative micromachining technologies that lend themselves to the low cost manufacturing techniques associated with chip design and fabrication.

- Develop, demonstrate, and mature a new generation of IMUs which are highly reliable, one-fourth the cost, and one-third the size of current systems. They will also have dual use potential for commercial sensing devices.

Antimateriel Munitions

The Antimateriel Munition of the future is envisioned as a second generation smart submunition that will combine autonomous target classification with significantly increased area coverage with a selectable multimode warhead. This subthrust is developing the integration technology for the warhead, seeker, and airframe subsystems against the full spectrum of ground mobile and relocatable targets. The focus is on the development of an affordable diode pumped laser radar seeker which can classify, in real time, targets such as tanks, trucks, relocatable missile launchers, or radar sites. Other seeker technology such as MMW is also being investigated

Mobile targets such as tanks, trucks, relocatable missile launchers, or radar sites have special seeker requirements for both stand-off and direct attack deliveries. The seeker provides highly accurate guidance, and enough information to determine which warhead mode should be used to maximize target lethality.

- Develop an improved, low cost seeker which combines autonomous target recognition and tracking of mobile targets in weather with increased area coverage.

Distinguishing friend from foe when forces are in close contact is required for all-weather environments. To accomplish this task, the seeker must have precise angular and range resolution together with the capability to process at extremely high data rates.

- Exploit the technologies of high resolution laser radar, optical processing, and image algebra to develop new seekers. These seekers will have high speed, compact, parallel processors capable of processing high resolution images in less than 10 milliseconds and algorithms which will find and recognize targets in an adverse weather, clutter/ countermeasure environment, using high resolution solid-state LADAR.

AIR-TO-AIR

Dual Range Missile

The Dual Range Missile subthrust is developing and demonstrating guidance and control technologies for enhancing the close-in combat capability of air-to-air missiles. It is also pursuing terminal seekers with extended acquisition range, and advanced propulsion for extended flyout ranges. Technologies for

expanding the off-boresight launch angle capability are being emphasized.

Efforts relating to medium range missiles are primarily concentrated on technologies to improve the AIM-120 AMRAAM. These include lower cost components, increased electronic countermeasure resistance against a broader target spectrum, and identification of friend or foe.

- Develop and demonstrate a low cost seeker with an electronic steerable, conformal array antenna to provide rapid scanning of large fields-of-regard.

- Provide enhanced performance against post-2000 advanced electronic countermeasures and low observable threats.

- Develop a multimode seeker with enhanced processor hardware and algorithms to improve the target identification capability and end game accuracy.

- Provide acquisition and shoot-down capability of cruise missiles.

- Develop technologies for increasing missile maneuverability and high off-boresight launch capabilities. These technologies will provide increased first shot opportunities and minimize the time required for missile launch and destruction of the enemy aircraft.

- Develop advanced, low cost, supportable, munition control system technologies which provide decreased missile flight times, high off-boresight, and high angle-of-attack launch capabilities.

- Develop evaluation methods for dual range missile concept terminal flyout performance and effectiveness via simulation and analysis to include investigation of such concepts as guidance integrated fuzing, advanced fuze sensors, and advanced guidance and control technologies.

In addition to the target oriented goals listed above, there are goals for support technologies which apply across the board to all target types, for both air-to-air and air-to-surface. These include developing research test-beds, modeling, and simulation tools which reduce development and life cycle testing while providing specific seeker performance information as well as overall reliability, maintainability, and supportability data.

- Develop advanced guided munition simulation and simulator technologies and techniques in order to provide reliable and affordable assessments early in the seeker development process. Advancements in simulator scene projectors, scene generation computer codes and hardware, flight motion simulators, and real-time computer hardware will significantly increase the fidelity and utility of ground test facilities and reduce the magnitude of expensive flight test programs.

- Develop new target state estimation techniques, new guidance laws, and robust autopilot designs to optimize missile trajectories for faster intercept and increased terminal accuracy.

- Develop a fully integrated guidance and control system which is capable of providing higher single-shot-kill-probabilities for missiles such as AMRAAM.

- An additional goal is the development of an innovative guidance law to replace the time honored, but limited, "proportional navigation" guidance law which was invented in 1948.

MAJOR ACCOMPLISHMENTS

AIR-TO-SURFACE

Hard Target Smart Munition
Smart Soft Target Munition
Small Smart Bomb

- Fabricated and demonstrated large format (256 x 256), two color sequential readout, IR Multiple Quantum Well (MQW) IIR focal plane arrays which provide spatially-registered imagery in the midwave and long-wave IR for improved target detection and tracking.

- Conducted antijam GPS under the wing GPS acquisition in preparation for upcoming captive carry and free flight testing of JDAM weapons equipped with antijam GPS electronics and 4-element null steering antenna.

- Completed design of SAR seeker and Guided Bomb Unit (GBU)-15 weapon modifications. Received all long-lead hardware items and completed fabrication of the first of three SAR seekers. Began rooftop testing of the SAR seeker to verify transmit/receive functions, gimbal control, digital processor performance, adequacy of power supplies, and cooling system capability. Began fabrication of brackets and cables for the integration of the SAR seeker into the first GBU-15 weapon.

- Transitioned a passive conformal antenna system to the Advanced Antiradiation Guided Missile (AARGM) and HARM Program Office (PMA-242). This conformal antenna system has been adapted by F-18 and PAC3 program offices for application to their systems. Developed the design for a conformal SAR antenna system for application to ITAG/HAMMERHEAD under a SBIR Phase I program

- Successfully flew the F-16 in a 60 degree dive with a slow, skidding turn (no roll) through 80% of the Hammerhead weapon's free flight trajectory, thereby, demonstrating the ability of the F-16 aircraft to collect sufficient imaging data during captive flight testing of a SAR seeker.

- Developed an image processor that will operate on all pixels at the same time to achieve speeds thousands of times faster than the newest PCs at low unit cost.

- Under PAL1 prototyped and fabricated high performance low-power parallel processor chips containing 16, 48, and 64 processing elements.

- The Multisensor Modeling and Analysis (MSMA) program provided a method to predict weapon effectiveness of smart weapons for The Joint Technical Coordinating Group for Munitions Effectiveness. Enhancements were made to Irma's video simulation for Navy Coastal Systems Laboratory for use in developing multispectral algorithms for their Special Forces camera. Integrating Irma with a hardware-in-the-loop simulation provides realistic simulations of C-130 ground targeting and countermeasure effects for the Special Operations Command. The Army's Tank & Automotive Command's PRISM high-fidelity signature prediction model was incorporated in Irma.

- A solid-state zoom optical switchable lens system with no moving parts has been designed which provides three different search and tracking fields-of-view for LADAR. LADAR systems using this device can improve the detection range by a factor of 2 and simultaneously increase terminal impact accuracy.

- Initiated an in-house program to quantify the effects of adverse weather on LADAR. Tests with a direct detection LADAR system were conducted under fog, haze, and rain conditions over a 1.5 year period with approximately 1000 images being collected. These images are presently being analyzed to correlate the measured weather parameters with the number of dropout pixels and false returns and, subsequently, their effect on the autonomous target acquisition algorithms.

- Developed an in-house LADAR breadboard system which will allow the testing of new LADAR components and techniques. This breadboard system incorporates a two-wavelength laser allowing for eye-safe operation and the evaluation of new multi-wavelength target detection techniques.

- Completed, for the first time, a comprehensive solid-state LADAR captive flight test using a GPS controlled gimbaled LADAR sensor to collect signature data on foreign military mobile targets, spatial and range calibration targets, and fixed high value targets.

- Completed ground mobile testing of antijam integrated GPS/INS system against actual jammers representative of postulated jammer threat.

- Successfully completed free flight testing of GPS/INS guided small smart bomb. Navigation hardware included the TriService IMU. Differentially corrected GPS/INS guidance resulted in performance of less than 3 meters against surveyed targets.

Antimateriel Munitions

- Completed program to explore focal plane imaging of an active MMW radar. The method utilized over-sampling of phase and magnitude data contained within the radar receiver focal plane by using a multiple probe receiver assembly.

- The Optical Processor Enhanced LADAR (OPEL) program established the successful integration of a laser radar and an optical processor, for autonomous target selection and guidance of a smart weapon. LADAR fabrication was completed in mid-March. Developed draft test plans for both tower and captive flight tests. Tower testing at the Eglin Range occurred in early to mid-June.

- Initiated work on an electrically controlled 128x128 spatial light modulator that has gray scale capability. Successful completion of this project will have significant impact on the OPEL optical correlator.

- Designed an advanced readout and processing integrated circuit capable of operating with many different IR sensors. In particular, it can be used to enable a dual-color IR focal plane (which we are also developing) to detect low contrast moving targets embedded in IR clutter.

- Completed a state-of-the-art multidiscriminate LADAR system. Successfully conducted a major joint service data collection effort with the system involving both foreign and domestic mobile targets.

- Algorithms are being developed for solid state laser radar seekers to provide the capability for a weapon to autonomously detect and identify military vehicles even when protected by enemy countermeasures. Software has been developed that has a high percentage of successful identification rate using both measured data and synthetic data generated with Irma.

- Developed the Kinetic Hardware In the Loop Simulator (KHILS) LADAR Scene Projector (LRSP) to enhance current KHILS support of the Low Cost Autonomous Attack System (LOCAAS) program. Demonstrated the LRSP optical pulse injection as a feasible approach to LADAR scene projection for real-time test and evaluation of LADAR seekers.

- The RASER receive antenna was replaced with a focal plane receiver probe assembly. RASER was then configured to operate as a focal plane scanning imaging radar. Image construction algorithms were run on the collected data and a two dimensional image of the target scene was developed.

- State-of-the-art MMW Analysis of Passive Signatures (MAPS) mobile test-bed was completed. MAPS is providing Passive MMW imagery at 3 frequencies (35, 60, and 95 GHz), simultaneously. Over 200 Passive MMW Images were collected for use with optimal flow algorithms to demonstrate ranging from a two-dimensional passive MMW sensor. This imagery was taken from pseudo look down perspectives to simulate a typical low altitude flight path. Stereo pairs from closely spaced sequences were collected for the first time.

- Flight tested an integrated ladar seeker with a highly maneuverable submunition airframe for demonstrating system effectiveness against ground mobile targets.

AIR-TO-AIR

Dual Range Missile

- Completed the design of a Readout and Processing Integrated Circuit (ROPIC) that will be mated with a dual band MQW IR sensor forming an advanced biologically inspired (neuromorphic) sensor processor dubbed NeuroSeek. The NeuroSeek sensor can be used for enhanced detection of low contrast moving targets embedded in IR clutter.

- A miniature infrared sensor interface/control electronics has been developed. The electronics set is reconfigurable to support a multitude of single band and dual band infrared sensors.

- Demonstrated dynamic dual band, common aperture, infrared scene projector using two co-aligned 512 x 512 radiative element resistive arrays.
- Initiated design of a highly maneuverable missile capable of performing both short and medium range missions.

- Completed design and fabrication of micro-machined gyros and accelerometers. Conducted wafer level testing of these devices.

CHANGES FROM LAST YEAR

There were no major changes in this Thrust.

MILESTONES

AIR-TO-SURFACE

- Fabricate, demonstrate, and field test a high performance long-wave IR MQW Focal Plane Array (FPA) that operates at 77 degrees Kelvin and meets TOW-III sensor performance requirements in FY98.

- Develop and demonstrate a simultaneous readout 256 x 256 two color MQW IRFPA, and deliver prototypes to Ballistic Missile Defense Organization (BMDO) Advanced Sensor Technology Program (ASTP) in FY98. Award two color MQW camera option in FY98.

- Test 20 to 40 prototype PAL II chips with breadboards available for users in Feb 98. The lot 1 fabrication of PAL II chips will then begin in March FY98. A demonstration of a combined processor of PAL and OPEL will be set up in early FY98.

- Complete flight testing of antijam GPS technology against two separate realistic jamming environments in FY98.

- Fabricate and assemble components for the DASSL modular brassboard in FY98.

- Integrate and test low-power high-performance parallel processor chips containing multiple processors and a computer board which contains multiple chips and a host computer interface in early FY98. The computer chip and multiprocessor board will be marketed as commercial products in FY98.

- IRMA will insert improvements in ultraviolet, visible and infrared signature prediction. Other automatic target recognition (ATR) development will include government-owned algorithms for synthetic aperture radar in FY98.

- Will correlate and continue to collect weather parameters such as visibility and rain rate to dropout pixels and false returns in laser radar imagery collected in FY98.

- Implement multipulse logic into in-house breadboard laser radar system in FY98.

- Collect laser radar imagery with the two-wavelength laser radar system in FY98.

- Conduct RASER experiments to determine exploitable MMW phenomenology for the improvement of smart munition guidance systems in FY98.

- Explore active and passive real beam MMW imaging technologies for application to air-to-surface seeker in FY98.

- Final Integration and tests of a 4 x 4, W-Band, Passive Electronically Scanned Detector (ESD) array will be completed in FY98.

- A 16 channel Passive MMW direct detection MMIC array will be evaluated in FY98.

- Test analysis of the tower test of the OPEL processor and LADAR against tank targets. Additional lab tests will be conducted until Feb 98 leading to a captive flight test in a contractor-owned aircraft starting Apr 98 and ending in May 98. A miniaturized seeker/OPEL processor design will be completed in FY98.

- The SSLADE mobile target algorithms in a missile processor will be validated against measured data in a hardware-in-the-loop simulator in FY98.

- Complete design of aerodynamic guidance and control methods for below ground control in FY99.

- Develop a conformal SAR antenna system for application to ITAG/HAMMERHEAD under a Phase II SBIR in FY98. Test and demonstrate this conformal SAR antenna system in FY99.

- Captive flight testing of the SAR weapon for the Hammerhead program will begin in FY98, followed by free flight demonstrations in FY99.
- Develop and demonstrate a simultaneous readout 512 x 512 two color MQW IRFPA and deliver prototypes to BMDO's Discriminating Interceptor Technology Program (DITP) in FY99.

- Continue development of an even smaller and cheaper replacement for the FOG IMU. A Breadboard

will be delivered in FY98, a brassboard in FY99, and completely tested in FY99.

- Complete design of small smart bomb featuring range extension devices, precision guidance, and antijam GPS guidance in FY99.

- Perform laboratory and tower tests with the DASSL modular brassboard in FY99.

- Develop a scannerless laser radar system based on the Sandia National Laboratory concept by FY99.

- Finalize DASSL LADAR seeker designs for Small Smart Bomb and Cruise Missile in FY99.

- Complete bench tests of below ground guidance and control devices in FY00.

- Complete fabrication of small smart bomb integrated with range extension device precision guidance and antijam electronics in FY00.

- Captive flight test DASSL LADAR seeker for the Small Smart Bomb in FY00.

- Demonstrate real time targeting for a SAR seeker using either on-board or off-board sensor information in FY01.

- Continue development of a low cost, small, intelligent antijam GPS/INS guidance system. The preliminary schedule has a breadboard delivered in FY98, a brassboard in FY00, and program completion by FY01.

- Complete flight testing of precision guided Small Smart Bomb with integrated seeker and GPS/INS guidance in FY01.

AIR-TO-AIR

- With partial funding from the BMDO, we will fabricate the NeuroSeek system in FY98. Upon fabrication, integration with the interface/control electronics, and laboratory testing, the NeuroSeek sensor will be integrated into BMDO's ASTP flight test platform in FY98.

- Complete test vehicle design of highly agile air superiority missile capable of both short and medium range missions in FY98.

- Begin developing and testing affordable, passive, electro-optical/infrared seekers which are sensitive to longwave infrared, multicolor, and polarization signatures to provide improved air-to-air terminal seekers in FY98.

- The Conformal Passive Adjunct Seeker Antenna for AMRAAM will be interfaced with the RASER and operated in the Tower facility, FY98. Real-time testing and experimenting of the target detection and tracking algorithms will take place in FY98.

- Complete designs of air-breathing air-to-air missile capable of extended range at increased average velocity in FY98

- An air-to-air capability will be added to the IRMA model with plume and cloud models and signature modeling capability from the Composite, High Altitude, Maneuvering, Postboost Vehicle Program will be applied to air-to-air scene generation and analysis in FY98.

- Continue development of very small micromachined gyros and accelerometers which promise to be a smaller and cheaper replacement for FOG and RLG IMUs. A breadboard will be delivered in FY98, a brassboard in FY99, and completely tested in FY99.

- Fabricate the conformal seeker breadboard and begin testing in FY98. Complete testing and demonstration of CAST breadboard seeker in FY99.

- Flight Control System design and simulation development for agile, dual range missiles for improving missile lethality by incorporating advances in automatic controls will be conducted in FY98, hardware-in-the-loop simulated in FY99, and flight tested in FY00.

- Begin Conformal Array Seeker (CAS) brassboard development for Dual Range Missile (DRM) demonstration in FY99.

- Complete wind tunnel tests of air-breathing, advanced air-to-air missile configuration in FY00.

- Complete fabrication of ground test vehicles for bench testing of air superiority missile in FY00.

- Complete ground tests and fabricate flight test vehicles for air superiority missile in FY01.

- Complete free flight tests of highly agile, air superiority missile capable of performing both short and medium range missions in FY02.

- Develop designs for advanced air-to-air missile incorporating high off-boresight seeker to allow all aspect engagement in FY02.

- Conduct ground tests of all aspect seeker integrated with highly agile, dual range missile in FY03.

USER NEEDS

The focus of this Thrust is to provide affordable, high probability of kill, conventional weapons to the Air Force inventory. The user needs presented below are extracted from Operational Requirements Documents, munitions Technical Planning Integrated Product Team (TPIPT) study efforts, the ACC Mission Area Plans for Aerospace Control, Strategic Attack/Interdiction, Close Air Support/Interdiction, Theater Missile Defense, Electronic Combat, and the Air Force Special Operations Command (AFSOC) Weapons System's Roadmap, 2nd Edition.

AIR-TO-SURFACE

Hard Target Smart Munition

- Capability against deeply buried, hardened targets
- Improve warhead lethality with minimal collateral damage
- Increased aircraft loadouts through reduced warhead size and compressed carriage
- Smart fuzing to optimize warhead burst point
- Increased mission kill capability and payload flexibility
- Ability for nuclear, biological and chemical weapon defeat and containment
- Real-time battle damage assessment

Smart Soft Target Munition

- Improved warhead lethality
- Munition packages which reduce airlift support requirements
- Effectiveness against area targets
- Capability to control weapon's height of burst
- Reduce susceptibility to countermeasures

Small Smart Bomb

- Improve warhead lethality
- Multiple kills per pass
- Minimize/negate collateral damage
- Increased aircraft loadouts through reduced warhead size and compressed carriage
- Munition packages which reduce airlift support requirements

Antimateriel Munition

- Realtime target kill capability vs small/mobile targets
- Preemptive lethal SEAD
- Improved warhead lethality
- Reduce susceptibility of munition to countermeasures
- Reduced cost per kill and increased kills per aircraft sortie

AIR-TO-AIR

Dual Range Missile

- Improved AIM-120 lethality
- Improved warhead lethality
- Cruise missile kill and low observable kill capability
- Reduced susceptibility to countermeasures
- Increased maneuverability, performance, and aircraft loadouts

See Figure 6 for major Thrust efforts.

GOALS

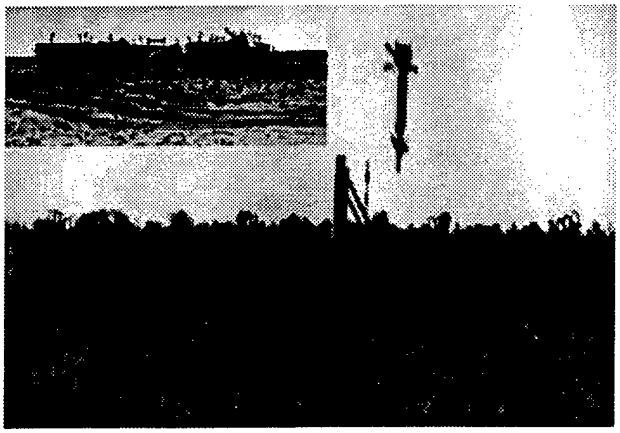


FIGURE 7. PENETRATION TEST ON HARDENED BUNKER

AIR-TO-SURFACE

Hard Target Smart Munition

The Hard Target Smart Munition subthrust is

ORDNANCE THRUST

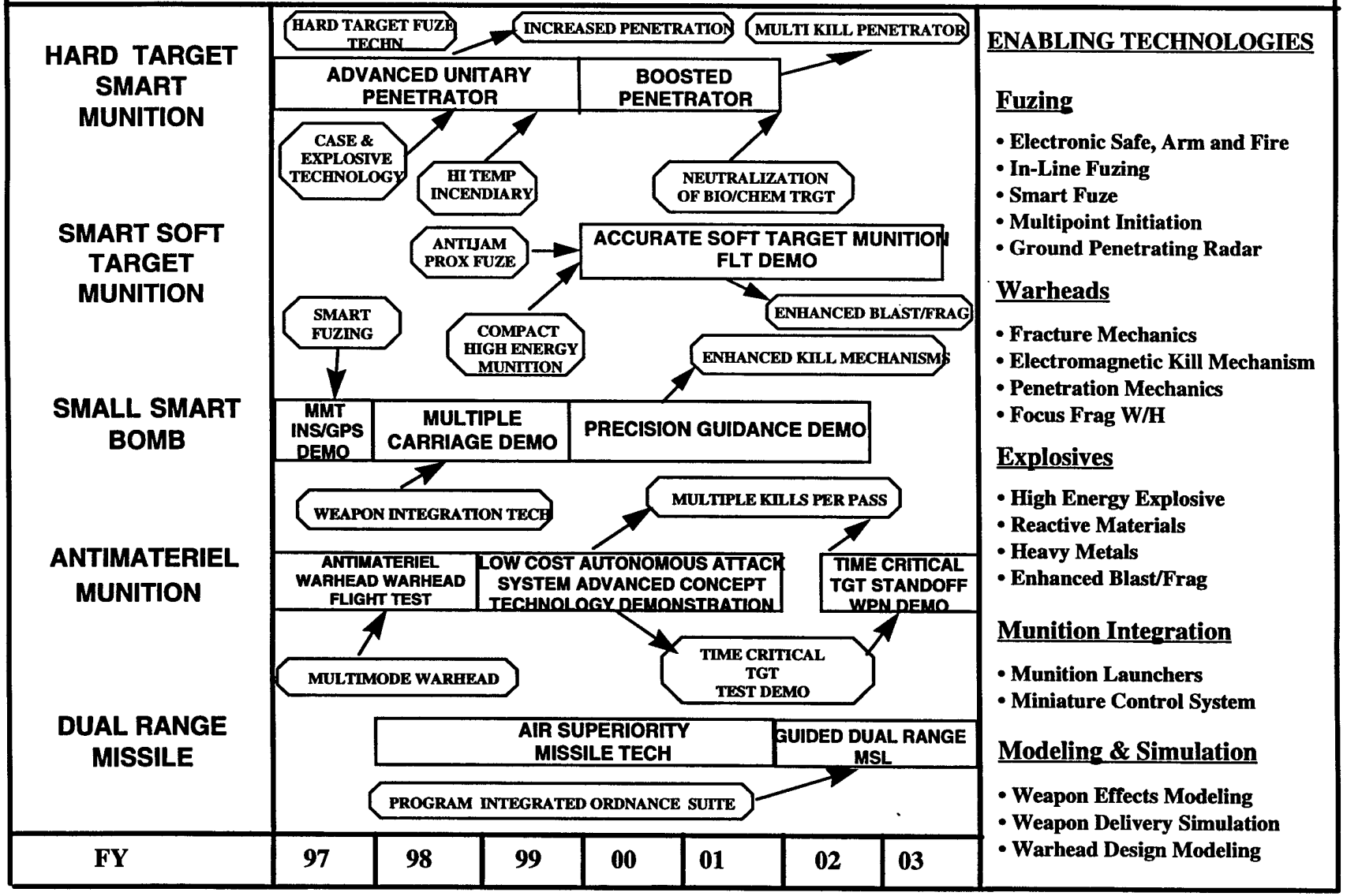


FIGURE 6: ORDNANCE THRUST

developing advanced penetrator warhead technologies for use against fixed and hardened targets. The Ordnance Thrust is focused on **developing ordnance capable of penetrating complex hard targets such as heavily hardened command and control bunkers (Figure 7), aircraft shelters, runways, and concrete buildings.** It is also focused on developing smart fuzing technology with layer counting, depth of burial, void sensing, programmable time delay capabilities and multiple event capability. To improve weapon accuracy and performance, we use low cost inertial guidance and optimized impact conditions through trajectory shaping and the use of reaction control systems so that the weapon and weapon velocity are orthogonal to the target plane at impact for better penetration.

For a given impact velocity, the penetration capability decreases with the decreasing size and weight of the penetrator. However, the number of weapons that a platform can carry increases with the decrease in penetrator weight. Extensive trade studies based upon cost and effectiveness indicate that a two-pronged approach is best: a high payoff, deep penetration capability and an increased force multiplier capability (carriage of more weapons). Warhead case and hard target fuzing technologies are emphasized to reduce cost, improve productivity, and increase reliability of penetrator munitions.

- Develop velocity augmented warhead technology which can accelerate warheads for deep penetration, but at sizes and weights which can be carried on a variety of attack aircraft. The ordnance package would be an option for a replacement for the gravity drop BLU-109 warhead presently planned for JDAM.

- Develop options for heavy metal penetrating warheads. The payoff would be improved penetration over the present steel case designs (more weight per cross section) for both gravity and velocity augmented concepts.

- Develop penetrating munitions compatible with standoff carrier vehicles for use in preemptive strikes against high value targets.

- Develop very high speed, 4000 to 7000 feet per second, penetrating munition technologies in explosives, fuzing, warhead materials and penetrator design.

Operational effectiveness is degraded when using fixed time delay fuzing because accurate intelligence data on the design and construction of all hard targets is lacking. A layer counting fuze with an improved void sensing capability only requires general construction data about a target to be optimally effective.

- Develop a smart fuze with improved void sensing and depth of burial capability to provide accurate warhead burst point control for complex hard targets. Reduce the size and cost of hard target fuzes while adding the capability to provide multiple fuzing events.

Penetrator design requires a thick walled warhead case for increasing penetration and ensuring warhead survivability during the penetration event. This thick wall requirement results in low volumes for explosive fills; which, in turn, drives a requirement for higher energy density explosives and new target defeat mechanisms. These advanced target defeat mechanisms can be used individually or combined to provide the effectiveness needed. Target defeat technologies are being developed to defeat large hardened targets such as command, control, and communication facilities and biological and chemical weapon facilities.

- Develop revolutionary explosive fills for penetrator warheads. High density fills with enhanced energy density will provide increased warhead penetration while providing enhanced lethality. This technology would increase the effectiveness of the smaller warhead options for JDAM product improvement.

- Develop electromagnetic energy weapon payloads which provide wide area mission kills against targets that rely upon computers, communication, and power systems. Methods for effectively coupling energy from the weapon into the target will be investigated.

- Develop warhead payloads for defeating/ neutralizing weapons of mass destruction. Investigation of explosives, catalysts, radiating sources and high temperature incendiaries as effective kill mechanisms will be accomplished. Technologies for denying enemy access to biological and chemical agents in hardened storage or production facilities will be addressed.

Battle damage assessment for hard buried targets is very difficult. Visual inspection of the target area usually provides little, if any, information on the weapon's effectiveness against the target. **Providing real-time data to airborne assets would maximize sortie effectiveness.**

- Develop miniature weapon borne sensor packages for penetrating warheads that will enable the transmission of battle damage information from inside the buried target. Technologies for transmitting data from within the buried target by radar frequency signals rather than a trailing wire hookup to the above ground relay will be pursued.

Current and developmental air-to-surface weapons are typically right circular cylinders with large aero-surfaces and control fins that steer the weapon to the target. These weapons require large areas/volumes for aircraft carriage and have large incarriage drag and signature. This type of control system provides limited maneuverability for optimum penetrator impact conditions. Reaction jet control technology coupled with an on-board inertial measurement unit and improved guidance laws reduce attack angles, thus optimizing the impact angle which significantly improves the weapon performance and effectiveness.

- Develop weapons which can be carried conformally or internally with minimum stowage volume. Implement control systems with minimum span aero-surfaces or reaction jet controls which provide additional reductions to weapon size. Resulting systems will be compatible with external carriage on current aircraft and internal carriage on future advanced fighter aircraft.

- Develop techniques for automatic rezoning of EPIC hydrocode meshes. Rezoning will improve the robustness of EPIC by eliminating the instabilities in hydrocode contact surface algorithms, resulting in more accurate and timely support applications.

- Develop 2D specialized penetrator prediction code for hard target applications. The capability of rapid design, usability, and accuracy will reduce support response time while providing a quality simulation.

- Develop a penetration toolkit for conceptual design. Analytical and empirical tools will be developed for quick turnaround of preliminary penetrator concept design with order of magnitude improvement.

- Complete the EPIC 97 hydrocode development. Final code will enhance ability to provide state-of-the-art 3D penetrator/target simulations on a more timely basis.

- Develop parallelized version of EPIC code. Parallelization will increase the scope of potential applications by allowing the use of finer resolution meshes on problems that require more precise results.

- Develop case fracture prediction techniques. Technology will result in improved capability to predict bomb case survivability during penetration of hard targets.

- Develop detailed Six-Degree-of-Freedom (6-DOF) simulations to predict/optimize flyout and terminal performance of munitions with advanced aerodynamic control technology and conformal shapes.

Smart Soft Target Munition

This Integrating Concept is developing very low cost, standoff technologies which when integrated, provide a highly effective munition against soft targets. Inertial navigation technologies are being pursued to reduce the munitions CEP. Technologies for producing multiple modes of operation for a single bomb are being developed. Improved proximity sensors that are countermeasure resistant and which provide high resolution on height above the ground for burst point control are being developed.

Soft Target Smart Munitions (general purpose bombs) use proximity sensors to increase blast and fragmentation effects on soft targets. The current general purpose bomb is the 2000 pound MK-84.

Aircraft costs are directly related to aircraft weight, thus a continuing emphasis is reduction in size and weight of the total weapon system (aircraft, suspension and release equipment, and armament). Kill mechanisms for delivering more energy on the target or more effectively coupling energy into the target are being explored. These technologies provide the opportunity to reduce the weapon size and weight while maintaining the

effectiveness currently available in larger munitions. Smaller, highly effective weapons result in reduced aircraft stowage volumes/areas and thus reduced aircraft size, weight, and costs.

- Develop and demonstrate innovative warhead, initiation, and explosive technologies for enhancing the effectiveness of 1000-lb class general purpose bombs so that their effectiveness is equivalent to the MK-84 2000-lb general purpose bomb. Technologies of interest include multiple initiation to focus fragmentation and control the size and distribution of fragments for enhanced lethality.

- Develop enhanced high energy explosives which increase blast and provide increased fragment velocities for improving warhead lethality.

- Develop innovative kill mechanisms which couple explosive and electrical energies to enhance the destructive power delivered to the target. Investigate capabilities obtainable from simultaneously applying multiple kill phenomenology to targets.

- Develop carriage and release technology to reduce supportability costs through advanced energy sources which replace pyrotechnic devices. This technology will allow increases in flexibility of weapon loadouts, accommodating a wide range of weapon types.

- Develop analysis and simulation capability for predicting the effects of novel kill mechanisms employed against a range of fixed soft targets including military headquarters buildings and high-value industrial sites.

- Perform comprehensive effectiveness trade studies for a wide range of aircraft and targets to determine goals for munition size/loadout and kill performance.

Current proximity sensors are expensive, bulky, and susceptible to ECM and jamming. Because they currently perform only the sensing function, the present bombs are required to carry a supporting initiation fuze which adds to the associated build-up costs of the bomb.

- Develop and demonstrate solid-state electronics and an ECM hardened proximity sensor for product improvement for the Joint Programmable Fuze.

- Develop monolithic microwave integrated circuits (MMIC) which provide frequency agility for countermeasure resistance while lowering the cost and improving the reliability and supportability of proximity sensors. Reduce sensor susceptibility to ECM jamming used to dud proximity fuzes and electromagnetic interference jamming from antiaircraft artillery and surface-to-air missiles.

- Incorporate all sensing and fuzing functions into a single soft target smart fuze.

- Perform comprehensive effectiveness trade studies for a wide range of aircraft and targets to determine goals for munition size/loadout and kill performance.

Small Smart Bomb

This Integrating Concept is developing a 250-lb class munition with a penetrating warhead and accurate guidance, compatible with very low cost standoff technologies. Enhanced energy/kill mechanism technologies are being emphasized. An all weather, precision terminal seeker compatible with the concept will be developed.

Future fighters, such as the Advanced Tactical Fighter and the Joint Strike Fighter, demand that the weapon payload size and weight be reduced. The SSB family of weapons will provide weapons which combine precision guidance with enhanced burst point control and enhanced energy explosive fills to defeat targets currently requiring much larger warheads. These technologies will reduce weapon cost while increasing aircraft loadouts and reducing sortie requirements.

- Develop advance high energy density explosives which enhance blast and increase fragment velocities. These explosive fills will provide the SSB with 50 percent greater effectiveness than provided by the current Tritonal explosive payload.
- Develop smart fuzing technology for 250-lb class weapons. Effective fuzing against thin layered structures as well as hardened targets consisting of up to 6 feet of reinforced concrete is required. Improved sensitivity for detecting the initial transition from one layer of target media to another is required in order to detonate the explosive payload in the proper location. Technologies for improving the fuze's media discrimination capabilities will be developed.

• Develop inertial aided small bomb technologies for hard targets which would provide multiple carriage per aircraft station and defeat multiple targets on a single sortie. Technologies required are low cost inertial guidance and second generation Smart Fuzing (autonomous decision making rather than preprogrammed).

• Develop miniature munitions which integrate advanced ordnance technologies developed under the Smart Hard Target Munition and Smart Soft Target Munition areas to provide a family of weapons with increased loadouts and sortie effectiveness. For the first generation of small munitions, develop a 250-lb warhead capable of penetrating 6 feet of concrete and defeating 85 percent of the BLU-109 target set. This first demonstration will utilize a GPS/INS guidance system. Demonstrate in a follow-on demonstration an integrated terminal seeker version of the miniature munition and technologies for enhancing warhead effectiveness against soft targets.

• Develop simulations to evaluate the requirements and performance of various component technologies when applied to the basic Small Smart Bomb. Fuzing, standoff, guidance, and warhead options will be evaluated both individually and in combinations.

• Develop ultrahigh speed, 1-5 million frames per second electronic imaging technology for measuring short duration transient phenomenon. The combination of pulsed laser illumination with this technology will offer completely new capabilities for studying warhead initiation and detonation physics.

Antimateriel Munition

This Integrating Concept is developing the integration technology for the warhead, seeker, and airframe subsystems and demonstrating the performance and effectiveness of the munition concept against the full spectrum of ground mobile and relocatable targets. A key aspect is the development and demonstration of a low observable, low drag, standoff dispenser for the antimateriel submunition.

Strategic attack, interdiction, and close air support will continue to be primary missions for advanced tactical aircraft. Targets include enemy air defenses, tactical ballistic missile sites, and the whole range of ground mobile targets such as those included in a motorized rifle battalion. Until recently, different warheads had to be fielded to get the optimum lethality for each different class of target. Armament Directorate in-house development has demonstrated the feasibility of a single warhead being initiated in any one of the three modes (long penetrating rod, explosively formed aerostable penetrator, or fragmentation). This technology breakthrough enables one submunition to be lethal against the wide spectrum of materiel targets.

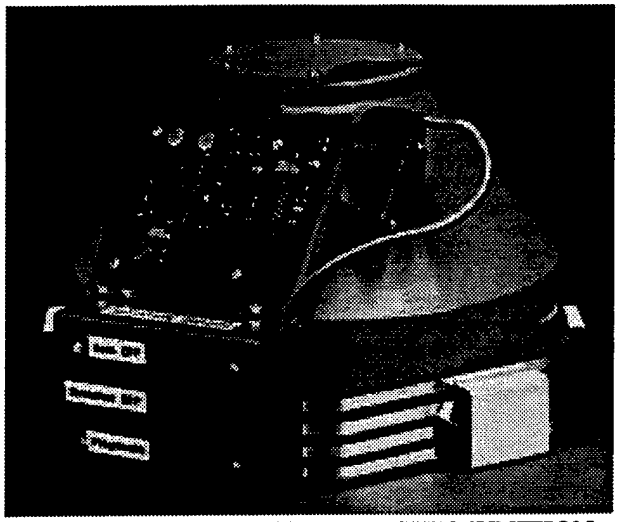


FIGURE 8. ANTIMATERIEL SUBMUNITION WARHEAD
(8.5 INCH DIAMETER, 6 INCHES HIGH)

• Continue advancement of multimode warhead technology which can be selectively fired as a penetrating jet, aerostable slug, or multiple fragments. This will provide technology options for next generation antimateriel submunitions. The Antimateriel Submunition Warhead is shown in Figure 8.

• Continue expansion of multiple point initiation technology to enhance the fragmentation pattern and number of fragments produced. Improved warhead lethality against soft ground mobile targets is the goal.

• Develop heavy metal antimateriel submunition liner technologies for increasing penetration against medium and heavily armored antimateriel targets. Tantalum and tantalum/tungsten alloys which provide desired fragmentation will be developed.

Current antimateriel submunitions are limited in their area coverage and search patterns. They also

have limited lethality against the broad spectrum of antimateriel targets which includes armored vehicles, trucks, and missile sites.

- Develop high density carriage and dispensing technology to allow large increase in aircraft loadout of antimateriel submunitions.

- Continue development of low cost antimateriel submunitions which provide significantly lower cost per kills than existing submunitions.

- Analytically assess the effectiveness of current multimode warhead design against varied target sets. The results will highlight design requirements for next generation antimateriel submunitions employing multiple kill mechanisms.

In order to maximize the number of kills per sortie, multiple kills of the same target must be avoided. Multiple autonomous munitions must have a method of coordinating an attack.

- Develop telemetry technology which will enable effective networking of multiple submunitions to maximize the number of kills per sortie.

- Refine LOCAAS flyout simulation to include latest contractor hardware changes for technology transition. Perform detailed assessments to aid program management decisions and evaluate technology options such as propulsion and various packaging designs.

AIR-TO-AIR

Dual Range Missile

This Integrating Concept is developing and demonstrating guidance and control technologies for enhancing the close-in combat capability of air-to-air missiles. It is also pursuing terminal seekers with extended acquisition range, and advanced propulsion for extended flyout ranges. Enhancement of air-to-air ordnance package performance requires that the target detection device and warhead burst point calculations use all information available to the missile. Effective coupling of the warhead energy onto the target requires improvements in directing the kill mechanism so that as much of the kill mechanism as possible interacts with the target. Data from the missile seeker can be used to project the encounter geometry and velocity. Further enhancement of the burst point control algorithms requires that the volume viewed by the target detection device be expanded to cover as much of missile's forward hemisphere as possible. Reductions in target signatures require that the fuze be capable of detecting low observable targets.

- Develop guidance integrated fuzing systems which accurately predict the relative target encounter conditions using all available data from the seeker and guidance systems.

- Develop an imaging fuze sensor which covers the forward hemisphere and provides missile/target encounter geometry refinement and a preferred target aimpoint for enhancing warhead burst point calculations and improving warhead effectiveness. Infrared and optical imaging technologies will provide improved capability against targets with low observable radar frequency signatures.

- Develop mass focusing warheads which direct the fragment and blast patterns so that the majority of the warhead energy is coupled into the target. Multiple point initiation technology for directing the warhead's lethality while reducing the overall warhead volume will be pursued. Technologies for producing multiple kill mechanisms which are matched to the target's vulnerability will be investigated.

- Develop an integrated ordnance package, fuze and warhead, which provides enhanced effectiveness against the full range of antiair targets - cruise missiles to bombers.
- Develop evaluation methods for dual range missile concept terminal flyout performance and effectiveness via simulation and analysis to include investigation of such concepts as guidance integrated fuzing, advanced fuze sensors, and advanced guidance and control technologies.

Improvements in enemy aircraft technology and the proliferation of advanced aircraft have resulted in nations possessing fighter aircraft nearly equal to our own. The weapons suite for these aircraft is in some areas (e.g., aerodynamics) superior to our current systems. Technologies such as reaction jets will reduce the need for missile fins, providing compressed missile carriage which will double missile loadouts for

a given carriage volume. This technology should be developed with the goal of supporting future product improvements to the AIM-9 Sidewinder and AIM-120 AMRAAM systems. Additionally, the munition control system technologies of the thrust are also applicable to the air-to-surface weapon systems.

- Develop technologies for increasing missile maneuverability and high off-boresight launch capabilities. These technologies will provide increased first shot opportunities and minimize the time required for missile launch and destruction of the enemy aircraft.

- Develop advanced, low cost, supportable, munition control system technologies which provide decreased missile flight times, high off-boresight, and high angle-of-attack launch capabilities.

MAJOR ACCOMPLISHMENTS

AIR-TO-SURFACE

Hard Target Smart Munition

- Completed concept trade studies and tungsten material assessment for 1000 pound dense metal penetrator.

- Developed and transitioned MEVA lethality/vulnerability modeling architecture for assessment of conceptual munition effectiveness.

- Completed design of inflatable nosecone concept for compressed 1000 lb. Munition. Reduces length 50%.

- Completed transition of computational fluid dynamics prediction techniques to the 46th Operations Group for implementation and use in the SEEK EAGLE store clearance and certification process.

- Completed hardware fabrication for high temperature incendiary agent defeat concept based upon BLU-109.

- Completed design and wind tunnel test of internetted unattended ground sensor - air delivery vehicle.

Smart Soft Target Munition

- Complete subscale evaluation of fragmentation control technology for advanced general purpose bombs.

- Completed demonstration of high energy explosive fill for MK-83 Energetic Fill program.

Small Smart Bomb

- Developed and demonstrated in full scale tests a high energy explosive fill for the small smart bomb. Effectiveness is 50 percent greater than Tritonal filled munition.

- Refined the baseline MMT 6-DOF simulation and performed studies to address transition and questions on technology options.

- Developed a low cost, high-resolution 1000 frame/second electronic imaging camera for dynamic munitions experiments.

- Completed wind tunnel testing for Miniature Munition Technology demonstration.

- Completed folding wing and fin deployment wind tunnel tests for small smart bomb configuration.

- Completed design of alternate energy source carriage and release equipment that reduces life cycle cost for application to JSF and other aircraft.

Antimateriel Munition

- Demonstrated low energy slapper detonator for antimateriel warhead applications. This patented device provides the technology breakthrough needed to expand the number of initiation points available for use in a multimode warhead.

- Completed demonstration of the Antimateriel Submunition warhead and delivered flight test warheads for the follow-on program.

- Completed LOCAAS simulation development to reflect the current technology configuration; validated the simulation against actual flight tests and performed comprehensive risk reduction analysis for current year flight demonstration.

- Completed definition of hypersonic weapon requirements for defeating SCUD targets.

AIR-TO-AIR

Dual Range Missile

- Completed trade studies for the Programmable Integrated Ordnance Suite (PIOS) program which is providing the fuze and warhead technology for the Dual Range Missile.

- Completed testing of jet reaction control device for air-to-air missiles.

CHANGES FROM LAST YEAR

There were no changes from last year.

MILESTONES

AIR-TO-SURFACE

- Complete preliminary design of dense metal case penetrating warhead which provides three times the penetration capability of high strength steel cases. Complete assessment of supporting tungsten alloy manufacturing and material properties in FY98.

- Deliver 2D penetration simulation code for user in hard target design applications in FY98.

- Demonstrate 2250-lb and 1000-lb warhead technology compatibility with inertial and precision guidance and develop flight control algorithms to ensure small angle-of-attack at impact in FY98.

- Deliver engineering prediction tool kit with graphical user interface for rapid penetrator design in FY98.

- Initiate a broad array of studies for the Small Smart Bomb Integrating Concept to determine component technology requirements for FY-98 and beyond.

- Complete flight testing of GPS guided air delivery vehicle for internetted unattended ground sensor in FY98.

- Complete wind tunnel tests of preferred compressed wing and fin configuration for small smart bomb in FY98.

- Complete radar cross section tests of aircraft carriage concepts for compressed weapon designs in FY98.

- Complete development of rapid response weapon designs for attacking time critical SCUD launcher target in FY98.

- Complete testing of airbag dispensing techniques for small smart munitions in FY98.

- Complete studies of captive dispenser requirements for F-22, JSF, and F-117 aircraft for carriage of small smart munitions in FY98.

- Complete ground and ejection testing of advanced carriage and release equipment for JSF aircraft application in FY98.

- Complete formulation and evaluation of high energy explosive fill for replacing Octal in antimateriel munition. New fill will reduce production processing and provide enhanced energy in FY98.
- Complete development, sled track demonstration and arena testing of 1000-lb class tungsten alloy case penetrator warhead in FY99.

- Perform subscale testing of high speed deep earth penetrating warhead concepts in FY99.

- Integrate the full capability to model enhanced energetics into the MEVA methodology for high confidence assessments of the defeat of the hard targets spectrum in FY99.

- Complete detail design of multievent hard target smart fuze for advanced penetrating warheads in FY99.

- Analytically assess the enhanced lethality of the 1000-lb advanced general purpose munition employing optimized kill mechanisms. Parametrically assess performance versus 2000-lb munition across entire soft target spectrum in FY99.

- Demonstrate 1 million frame/second electronic imaging system in FY99.

- Complete design of low cost dispenser capable of internal carriage of high loadout of small smart munitions in FY99.

- Complete design of small smart bomb featuring range extension devices, precision guidance, and antijam GPS guidance in FY99.

- Perform component integration and live fire flight testing of an all-up antimateriel submunition effective against all mobile ground targets in FY99.

- Configure a detailed simulation to represent the powered version of LOCAAS to provide advocacy and risk reduction analysis in FY99.

- Complete trade studies for revolutionary energetic fill for small smart bomb in FY00.

- Complete fabrication of low cost dispenser equipment in preparation of ground and flight testing in FY00.

- Complete design of fast response weapon concept in preparation for ground testing in FY00.
- Flight demonstrate high density packaging and dispense technologies for carriage and release of antimateriel submunitions in FY01.
- Complete captive flight tests of low cost dispenser integrated in F-117 aircraft in FY01.

- Complete sled track testing and arena testing of 1000 pound multipurpose warhead which combines penetrating capability and an effective general purpose bomb in a single warhead in FY02.

- Develop designs for dual mode, small smart bomb capable of defeating both surface fixed and bunkered targets in FY02.

- Complete fabrication of flight test vehicles for demonstrating efficient wing and fin deployment small smart munitions in FY02.

- Complete subscale testing of hypersonic weapon designs including wind tunnel, aero-thermal, and structural/material testing in FY02.

- Develop hypersonic dispenser designs capable of delivering conventional munitions from space in FY02.

- Complete fabrication and ground test of dual mode, small smart bomb in FY03.

- Complete flight test of efficient wing and fin deployment devices for small smart munitions in FY03.

- Complete full-scale, sled track tests of hypersonic weapon designs to evaluate ability of subsystems to endure aero-thermal loads associated with Mach 6 travel in FY03.

- Complete fabrication of hypersonic weapon dispenser for employing conventional weapons from space in FY03.

AIR-TO-AIR

- Complete preliminary design of programmable integrated ordnance package for future air-to-air missiles in FY98.

- Complete development of flight control software for highly maneuverable, missile incorporating, hybrid reaction jet/aerodynamic flight controls in FY98.

- Complete ground test of advanced weapon carriage and release equipment for application to JAST and other aircraft in FY98.

- Complete development of a 6-DOF simulation of a benchmark missile for exploring technology options on the dual range missile integrating concept. Perform requirements and performance analysis in FY98.

- Complete testing of imaging target detection device and electronic safe, arm, and fire device in FY00.

- Complete flight testing of reaction jet control system for missile agility and performance improved for short and medium range in FY00.

- Complete demonstration of programmable integrated ordnance package for future air-to-air missile in FY01.

- Complete flight testing of air superiority missile technology providing short and medium range capability in FY01.

GLOSSARY

AARGM	Advanced Antiradiation Guided Missile
A/C	Aircraft
ACC	Air Combat Command
ADV	Advanced
AFAE	Air Force Acquisition Executive
AFB	Air Force Base
AFDTC	Air Force Development Test Center
AFOSR	Air Force Office of Scientific Research
AFSOC	Air Force Special Operations Command
AGM	Air-to-Ground Missile
AGRF	Advanced Guidance Research Facility
AIM	Air Intercept Missile
AMRAAM	Advanced Medium Range Air-to-Air Missile
ARPA	Advanced Research Project Office
A-S	Air-to-Surface
ASTP	Advanced Sensor Technology Program
ATR	Automatic Target Recognition
BLU	Bomb Live Unit
BMDO	Ballistic Missile Defense Organization
CAS	Conformal Array Seeker
CCD	Charge Coupled Device
CEP	Circular Error Probable
DASSL	Demonstration of Advanced Solid State Ladar
DoD	Department of Defense
DEMO	Demonstration
DEV	Development
DRM	Dual Range Missile
EO	Electro-optical
ECM	Electronic Countermeasure
EMD	Engineering Manufacturing Development
ESD	Electronically Scanned Detector
FY	Fiscal Year
FPA	Focal Plane Array
FOG	Fiber Optic Gyro
GBU	Guided Bomb Unit
GPS	Global Positioning System
HIPRA	High Speed Digital Processor Architecture
HTSM	Hard Target Smart Munition
ICIPT	Integrating Concept Integrated Product Team
IFRPA	Infrared Focal Plan Array
IMU	Inertial Measurement Unit
IR	Infrared
IRMA	Infrared Modeling and Analysis
IPT	Integrated Product Team
JAST	Joint Advanced Strike Technology
JDAM	Joint Direct Attack Munition
JSOW	Joint Standoff Weapon
JSF	Joint Strike Fighter
KHIL	Kinetic Hardware In-the-Loop
LADAR	Laser Radar
lb	pound
LOCAAS	Low Cost Anti-Materiel Submunition
MACET	Modular Algorithm Concept Evaluation Tool
MAP	Mission Area Plan
MMIC	Monolithic Microwave Integrated Circuits
mm	Millimeter
MMTD	Miniaturized Munition Technology Demonstration
MMW	Millimeter Wave
MRMS	MMW Reflectivity Measurement System
MSMA	Multi Sensor Modeling & Analysis
MUN	Munition
NASP	National Aerospace Plane
NAV	Navigation
OSD	Office Secretary of Defense
OPEL	Optical Processor Enhanced Ladar
PAL	Programmable Algebraic Logic
PE	Program Element
P^3I; P3I	Pre-planned Product Improvement

PIP	Product Improvement Program
PIOS	Programmable Integrated Ordnance Suite
RASER	Research and Seeker Emulation Radar
RF	Radio Frequency
ROPIC	Readout & Processing Integrated Circuit
S&T	Science and Technology
SADARM	Search and Destroy Armor Munition
SAR	Synthetic Aperture Radar
SCUD	Short Range Ballistic Missile
SEAD	
SEEK EAGLE	Aircraft/Weapon Certification Program
SFW	Sensor Fuzed Weapon
STAG	Smart Tactical Autonomous Guidance
SPO	System Program Office
SSB	Small Smart Bomb
SSTM	Smart Soft Target Munition
SUBMIN	Subminiature
SUBMUN	Submunition
TAP	Technology Area Plan
TDP	Time Space-Position-Information Data Processor
TIPP	Test Instrument Planning and Programming
TEO	Technology Executive Officer
TM	Telemetry
TPIPT	Technology Planning Integrated Product Team
TSPI	Time-Space-Position-Information
UAV	Unmanned Air Vehicle
WPN	Weapon

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